

Climate Resources: Ballard Mine (2/25/2016)

In order to assist in the consideration of climate change into the FS for Ballard Mine, I have compiled some information that I thought would be useful. The historical precipitation data provides an understanding of the most extreme precipitation events that have occurred over the past 35 years. This could provide information helpful when scoping out the alternatives for the FS. The climate projection information provides a sense of what is projected to occur at different time periods in regard to temperature, precipitation, and snowpack. There is currently very limited information on projections for increasing/decreasing frequency, duration, and intensity of precipitation events. The limited modeling that has been done indicates some increase in the frequency, duration, and intensity of precipitation events in the future but this is an evolving area. If you have any questions I am happy to discuss. Michael Cox 206-553-1597 or cox.michael@epa.gov.

1. Precipitation Frequency Data

Source: Hydrometeorological Design Studies Center – NOAA National Weather Services (accessed 2/23/16)

<http://www.nws.noaa.gov/ohd/hdsc/>

Ballard Mine: Lat: 42.8225 Long: 111.47333333

There are several maps with different precipitation frequency data. I have included examples below.

Map	Precipitation (Inches)	Precipitation Intensity (in/hr)
2-year, 6-hour event	0.79	0.13
2-year, 24-hour event	1.30	0.05
100-year, 6-hour event	1.78	0.30
100-year, 24-hour event	2.19	0.12

2. Historical Precipitation

Source: PRISM – Northwest Alliance for Computational Science and Engineering (accessed 2/23/16)

<http://www.prism.oregonstate.edu/>

Ballard Mine: Lat: 42.8225 Long: 111.47333333

Time Period: 1/1/1981 – 2/23/2016

10 Highest Daily Precipitation totals for time period.

Date	Precipitation Amount (inches)
10/25/2010	1.61
5/6/1993	1.5
9/16/2015	1.39
6/11/2004	1.25
8/23/2014	1.16
9/12/1985	1.13
5/7/1993	1.08
9/17/2015	1.07
3/5/1991	1.06

Time Period: 1981 – 2014

Average, highest, and lowest monthly totals for time periods.

Month	Average Precipitation (inches)	Highest Total Precipitation (inches)	Lowest Total Precipitation (inches)
January	2.42	4.6 (1998)	0.62 (1992)
February	1.86	6.16 (1986)	0.3 (1986)
March	2.03	3.97 (1995)	0.67 (1994)
April	1.99	4.24 (1986)	0.47 (1987)
May	2.73	5.66 (2015)	0.7 (1992)
June	1.85	5.97 (2009)	0.18 (2012)
July	1.15	3.2 (1987)	0.08 (2008)
August	1.16	4.82 (2014)	0 (2002)
September	1.45	4.01 (1982)	0.15 (1987)
October	1.87	3.71 (2004)	0 (1988)
November	2.33	5.01 (1988)	0.45 (2009)
December	2.53	8.69 (1996)	0.3 (1986)
Annual	23.38	34.46 (1983)	16.55 (1992)

3. Snowmelt and rain-on-snow events

A potentially important area to consider is rain-on-snow events and its impacts on runoff and whether those events may increase in duration, frequency and intensity in the future. I assume folks are familiar with two documents that provide equations for determining snowmelt and possible outcomes from rain-on-snow events but I have included below.

- 1998 Army Corps of Engineers Engineering Manual (EM 1110-2-1406)
http://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_1110-2-1406.pdf
- 2004 document from the Natural Resources Conservation Service Part 630 Hydrology National Engineering Handbook: Chapter 11 - Snowmelt.
<http://www.wcc.nrcs.usda.gov/ftpref/wntsc/H&H/NEHhydrology/ch11.pdf>.

Source: Western Regional Climate Center – Desert Research Institute

Data for Henry Idaho from 9/23/1971 to 01/31/2013

<http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?id4230>

Month	Average Total Snowfall (in.)	Three Highest Daily Snowfalls (in.)	Average Snow Depth (in)	Highest Snow Depth (in.)
January	16.4	8.0 (1/2/77) 9.2 (1/23/82) 15.2 (1/10/80)	25	56 (multiple dates 1986)
February	15.2	8.0 (2/23/87) 8.6 (2/13/87) 14 (2/9/85)	32	57 (2/12/75) 60 (2/21/86) 62 (2/20/85)
March	8.5	6 (3/12/85) 6 (3/21/85) 10 (3/5/74)	23	75 (multiple dates 1985)

April	3.8	5.0 (9/12/72) 5.6 (4/13/86) 5.6 (4/3/83)	7	40 (multiple dates in 1976)
May	1.2	3.0 (5/22/86) 3.6 (5/6/84) 4.4 (5/11/83)	0	10 (5/17/77) 5 (5/8/79) 5 (5/19/77)
June - October	0 - 2.2	-----	0	-----
November	13.6	9.2 (11/18/86) 11 (12/25/85) 12 (11/22/77)	3	21 (11/24/85) 32 (11/25/85) 38 (11/29/85)
December	16.1	8.2 (12/30/81) 8.6 (12/2/85) 9.0 (12/15/84)	15	49 (12/3/85) 50 (12/30/85) 53 (12/18/85)

4. Climate Projections

Source: USGS Regional Climate Change Viewer (accessed February 25 2016)

<http://regclim.coas.oregonstate.edu/visualization/rccv/hydrology/index.html>

Historical and Projected information for Blackfoot watershed (1980 – 1999 base period)

Dates	Ave. Annual Temperature (Celsius)	Ave. August Temperature (Celsius)	Ave. Annual Precipitation (mm/day)	Ave. December Precipitation (mm/day)	Ave. March Snow Water Equivalent (mm)
1980-1999	2.2	14.6	3.7	4.7	679
2040-2049	3.2	15.8	2.7	5.1	421
2060-2069	4.6	17.5	2.7	4.9	330
2090-2099	7.3	19.4	4.3	5.6	287

5. Climate Projections

Source: USGS National Climate Change Viewer (accessed February 25 2016)

http://www.usgs.gov/climate_landuse/clu_rd/nccv.asp

Historical and projected information are for the Blackfoot watershed. The base period is 1950 – 2005.

There is a range of values because of different emission scenarios.

Dates	August Evaporative Deficit (*) (mm/month)	April Runoff (**) (mm/month)
1950-2005	40.5	7.4
2025-2049	58.0 – 60.1	19.5-21.8
2050-2074	63.8 – 76.6	23.3-25.8
2075-2099	68.9 – 95.8	24.8-27.2

Values are the average depth for each variable in mm over the Blackfoot watershed.

* The evaporative deficit is the difference between the potential evapotranspiration, which is the amount of evapotranspiration that would occur if unlimited water were available, and the actual evapotranspiration which is what occurs when water is limited.

** Runoff is the sum of direct runoff that occurs from precipitation and snow melt and surplus runoff which occurs when soil moisture is at 100% capacity.

6. Climate Projections

Source: EPA Climate Ready Utilities Program

<http://www.epa.gov/crwu/view-your-water-utilitys-climate-projection-scenario-based-projected-changes-map>

The projected climate conditions are from a climate station located southwest of the Ballard mine very near Conda. The projection is for the percent change in the total precipitation expected during a 100 year storm event. The base period is 1981-2010.

- Period 2026-2045 = Increase of total precipitation of between 7.4 and 13.3 percent.
- Period 2051-2070 = Increase in total precipitation of between 14.1 to 25.8 percent.